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GAINS AND GOALS
of Forest Products Research

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Some half-century highlights in the work and aims of the U. S. Forest Products Laboratory.


United States
Department of Agriculture
Award for Distinguished Service
PRODUCTS LABORATORY, FS
MADISON, WIS
EZRA TAFT BENSON
SECRETARY OF AGRICULTURE

GAINS AND GOALS of Forest Products Research

FOREWORD

Justification for scientific research must stem from man's more effective control of his environment through the knowledge gained. What we see, hear, and otherwise perceive, whether unaided or with electron microscopes, radio telescopes, and other extensions of our sensory apparatus, means little except as we comprehend it and put it to use. Among living creatures, man is uniquely endowed to manipulate his environment. How he manipulates it—ignorantly and profligately, or intelligently and with due husbandry—will in great measure determine his tenure and the fees he must pay.

Those charged with operating public research institutions such as the Forest Products Laboratory must, of course, periodically report plans, programs, and findings. In addition, detailed reports, technical papers, and other literature are issued. From these, however, one is very likely to get a good picture only of trees; the overall import of the work—the view of the forest sketched in clear, bold strokes—is missing.

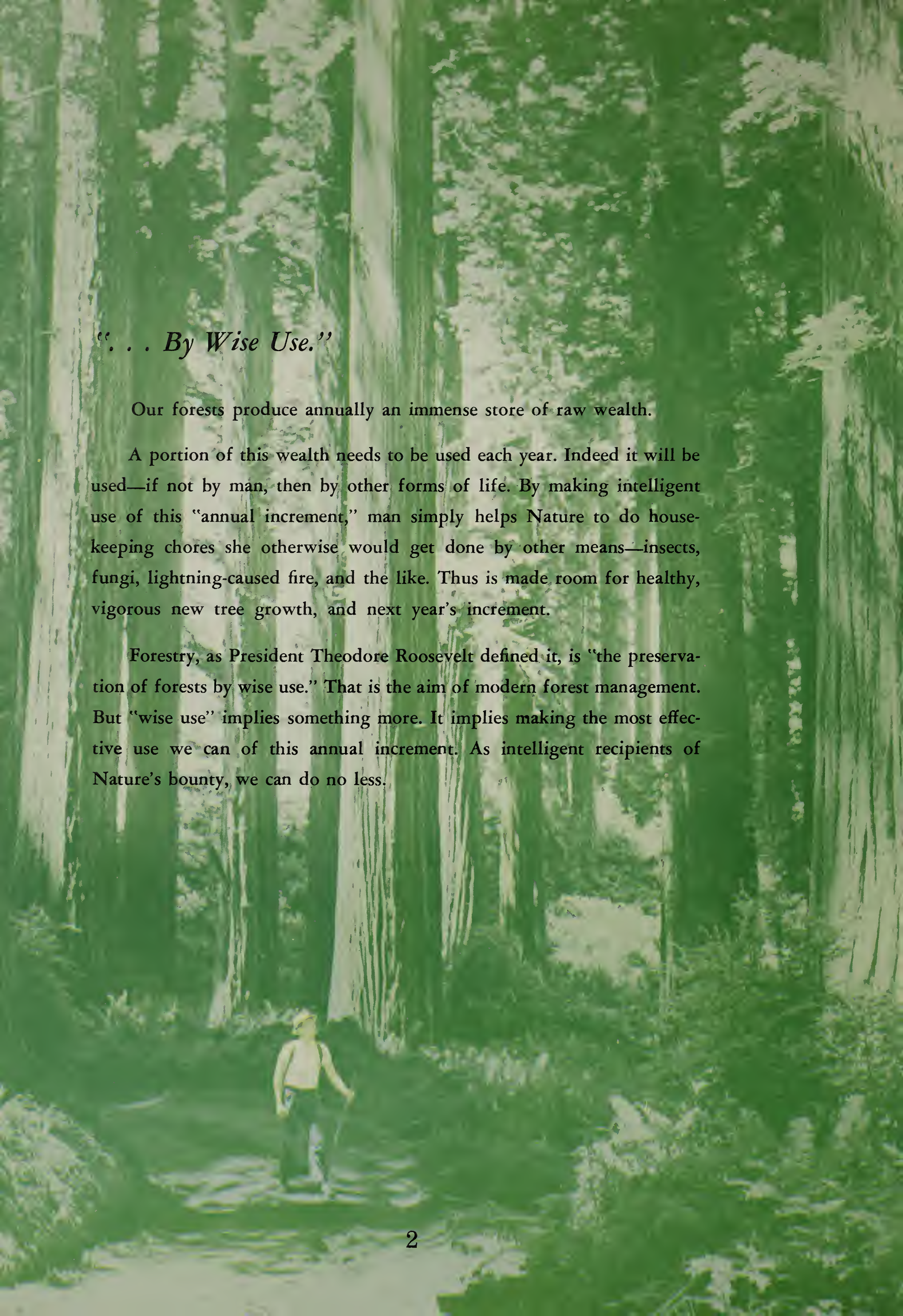
Perhaps as good a time as any to sketch overall progress and trends, as well as to project future goals, is an anniversary. Such a portrayal was undertaken by the men and women of the Forest Products Laboratory in observance of the golden anniversary of this institution June 4, 1960. The occasion was a three-day program June 2–4 to which friends and co-workers of the Laboratory from all parts of this country and many foreign lands were invited. Of special significance were the discussions of research progress and problems, past successes, and future needs presented by speakers representing industry, research, education, and government.

Against this background of discussion, some of the work of the Laboratory is described in capsule form in this anniversary booklet. Of necessity, only a few high points in the Laboratory's half-century history can be touched upon. In each instance, the significance of that work is brought out in quotations from discussions presented at the anniversary meeting.

It is the earnest hope of the employees and friends of this Laboratory who financially made possible the issuance of this booklet that its readers will gain a more comprehensive concept of the work done during these first fifty years, and of our continuing goals.

Edward G. Locke

Edward G. Locke, Director



". . . By Wise Use."

Our forests produce annually an immense store of raw wealth.

A portion of this wealth needs to be used each year. Indeed it will be used—if not by man, then by other forms of life. By making intelligent use of this "annual increment," man simply helps Nature to do housekeeping chores she otherwise would get done by other means—insects, fungi, lightning-caused fire, and the like. Thus is made room for healthy, vigorous new tree growth, and next year's increment.

Forestry, as President Theodore Roosevelt defined it, is "the preservation of forests by wise use." That is the aim of modern forest management. But "wise use" implies something more. It implies making the most effective use we can of this annual increment. As intelligent recipients of Nature's bounty, we can do no less.

"Within five years after its creation, the Forest Service was operating a forest products laboratory. This, I think, is evidence that forest utilization research has been a main point of the Forest Service program from the very beginning."

Richard E. McArdle, Chief, Forest Service.

It started back in 1910 . . .

The world's first laboratory organized specifically for purposeful research on wood and its myriad products was established at Madison, Wisconsin—a creature of Federal-State effort.

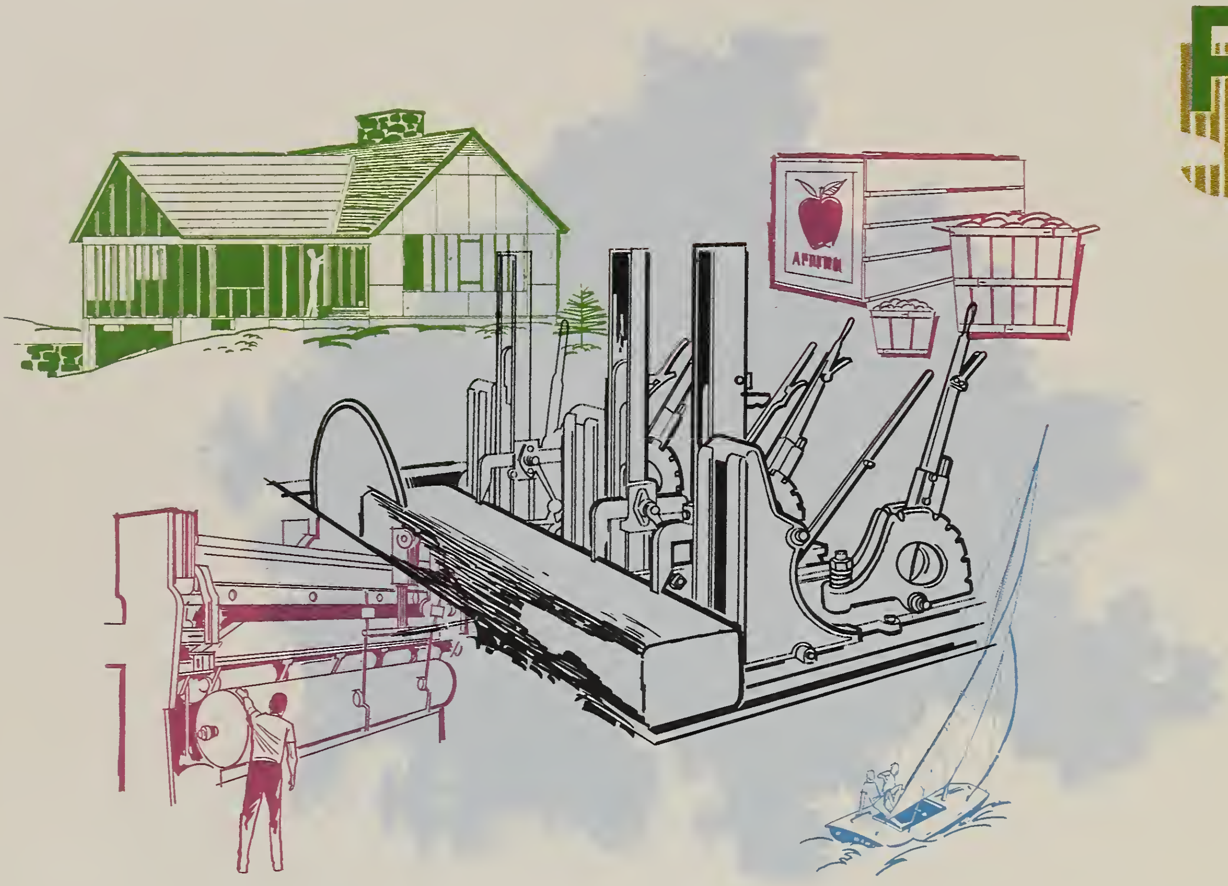
The University of Wisconsin erected a building on its Madison campus.

There the Forest Service of the U. S. Department of Agriculture brought together its engineers and scientists who had been working in locations scattered from coast to coast.

The Forest Products Laboratory was dedicated June 4, 1910.

"Our national land base is static; our land area is fixed . . . It now accommodates 180 million people . . . By the year 2,000 we may well be a Nation approaching a population of 400 million . . . all potential users of forest products."

Ervin L. Peterson, Assistant Secretary of Agriculture.



Goals for Research . . .

The fundamental purpose for which the Forest Products Laboratory exists is to provide knowledge needed to make more effective use of our timber resource. Toward fulfillment of this purpose, it proceeds along three broad lines of exploration.

1. Increasing the serviceability of wood products in whatever form.
2. Developing new uses for wood and improving existing ones.
3. Augmenting the usefulness and quality of all wood species.

Collectively, these three approaches take into account the interests of consumer, processor, and grower of timber. They thus constitute directional goals of an institution charged with broad national responsibilities in its sphere of operation.

"The innovations that have been brought about by science and technology . . . have changed human life more than it had changed in all previous centuries since the dawn of Man's first efforts toward civilization."

Conrad A. Elvehjem, President, University of Wisconsin.

The Gathering Years . . .

It is 1960. The harvest of half a century is in; the harvest of many minds, of uncounted ideas, of painstaking and persistent day-to-day efforts punctuated here and there by breakthroughs and dramatic surges forward. A harvest of knowledge and understanding of wood.

Over the span of fifty years the gains blend into a kind of varicolored mosaic recording and reflecting the pattern of our progress. Among the subdued tones denoting steady increment of basic knowledge flash vivid hues to accent prominent achievements.

From long, patient research on wood as a structural material have emerged such bold, revolutionizing concepts as the stressed-skin principle of panel design, the glued laminated arch, the structural sandwich.

Microscopic study of wood fibers, coupled with chemical research, has yielded processes and techniques that double and redouble the production potential of our forests for the paper and cellulose industries.

Add such notable advances as new preservatives that leave wood paintable and relatively odorfree; seasoning processes that accomplish in days what used to take months; all-weather plywoods serving equally well for housing or boat hulls—and you get some idea of the broad, constant benefits to our daily life gathered from the first half century of FPL research.

"Despite the proliferation of disciplines and subdisciplines, science remains essentially indivisible. We may fractionate it for our own convenience, but more and more frequently we find it necessary to break through whatever partitions we erect."

Samuel Lenher, Vice President,
E. I. du Pont de Nemours and Company.

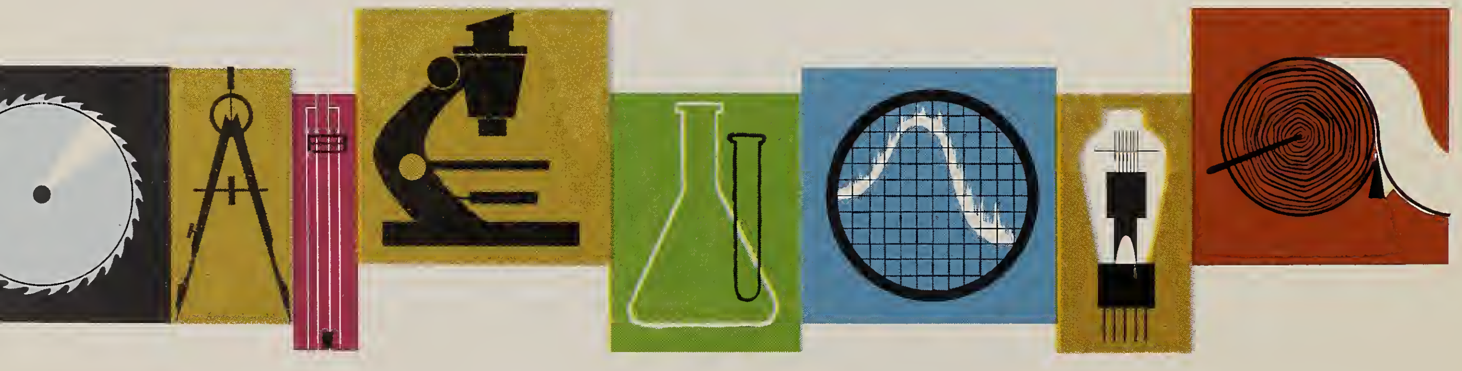
Of Many Callings

The many kinds of use we make of wood bring research demands that call into action most of the physical and biological sciences. FPL, therefore, is staffed with men and women trained in chemistry, physics, biochemistry, biology, pathology, mathematics, and such science-based callings as forestry, wood technology, and civil, chemical, and mechanical engineering.

The presence of these varied skills makes possible the broadest kind of scientific research program at FPL. But the result is not just a proliferation of research projects in many fields of science. The different callings are guided into a cohesive program each aspect of which is aided and fortified by the others.

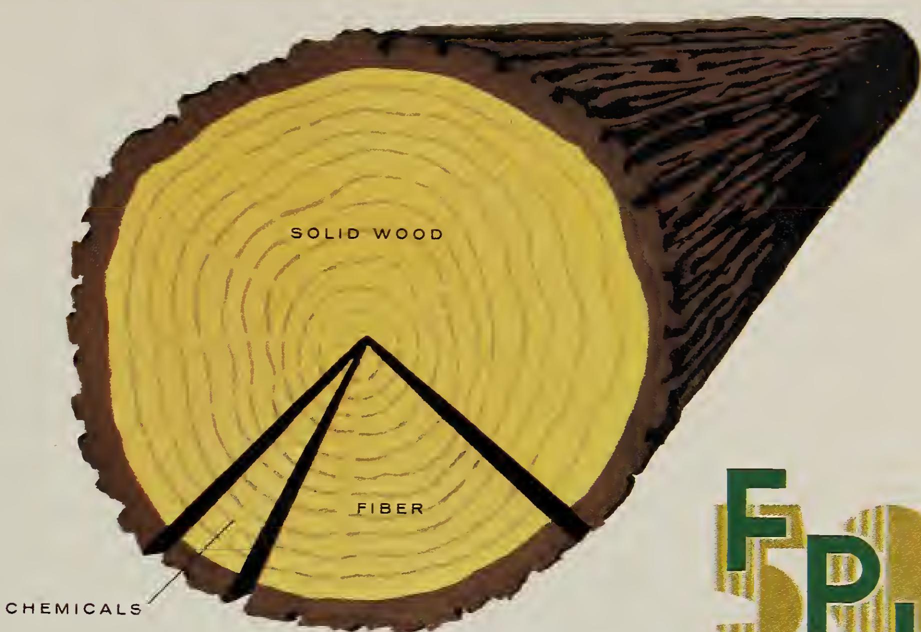
Thus, FPL research on the strength of wood is no mere matter of engineering averages. The botanist, with his knowledge of wood structure, is called upon to explain variations; the physicist for analysis of moisture, heat, and other effects; the chemist, perhaps, for adhesive behavior; the pathologist for evidence of deterioration; and so on.

The balanced investigations thus made possible account for much of the success the Laboratory has had during its first 50 years and why it is constantly called upon by industry, government agencies, and consumers for assistance in solving the practical problems of production and use.



"Man's use of wood is as old as the human race itself . . . But the curiosity of the twentieth century and the discoveries relative to the structure of matter have stimulated an intimate inquiry into the properties and applications of wood."

Gaylord Nelson, Governor of Wisconsin.



From the Oldest, the New

We use wood for three main classes of products: Those of solid wood, those of wood fiber, and those derived from its chemical constituents.

Until scarcely more than a hundred years ago, everything men made of wood was recognizably wood. This substance of trees was so handy, so plentiful and cheap, so strong for its weight, so easy to cut and shape and join that you didn't have to know much about it, really, to make extensive use of it. It is scarcely surprising, therefore, that even today we use it mostly in its natural state.

But wood, seemingly so simple and easy to manipulate, is amazingly complex and variable in physical structure and chemical composition. The valuable cellulose fibers are firmly cemented together with lignin, a substance whose make-up defies chemists. Yet wood fiber as a raw material has gained uses by the scores in paper and paperboard, insulating fiberboards, and structural hardboard.

As a source of chemicals, wood is regarded as only on the threshold of far-reaching economic usefulness. This despite the fact that already we get a great variety of products from its cellulose, its extractives, its bark, its lignin—things unrecognizable as of wood, like photographic film, synthetic textiles, plastics, adhesives, food flavorings, and tanning agents. Not to mention charcoal, a product of wood distillation! As research progresses, fiber and chemical uses are certain to take greater proportions of the log.

"The research conducted by the Forest Products Laboratory on the mechanical properties of wood has contributed immeasurably toward making wood a true engineering material."

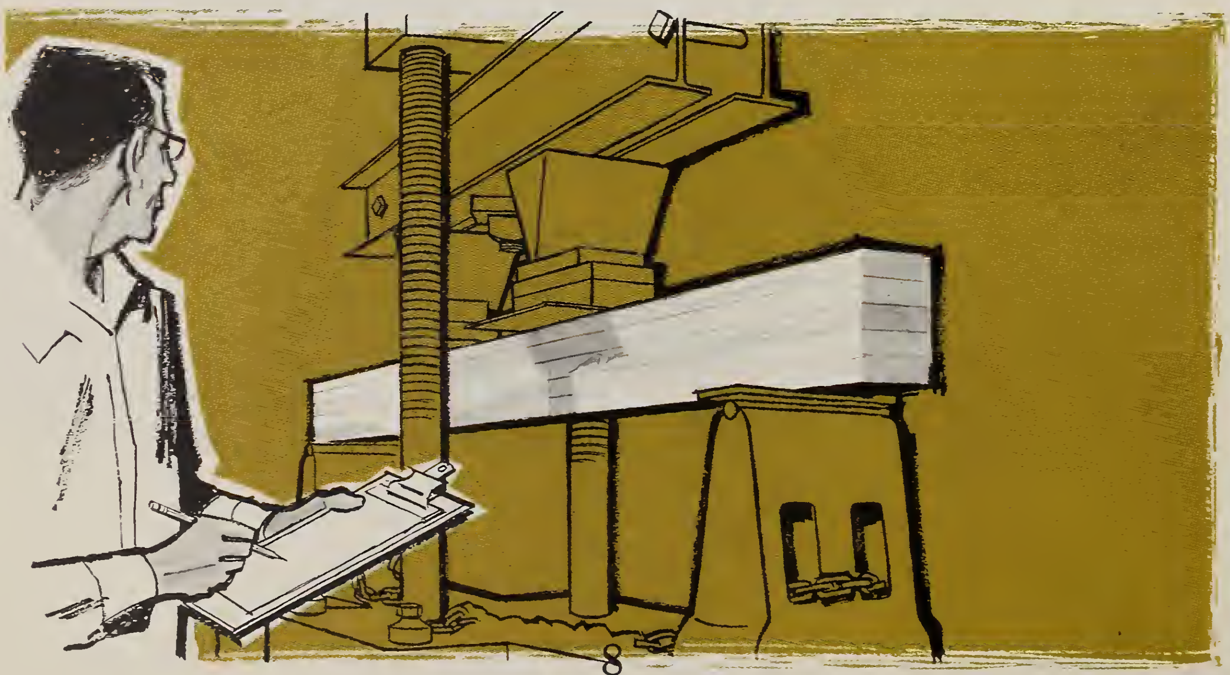
John G. Shope, Chief Engineer, National Lumber Manufacturers Association.

A Place to Start

By and large, wood's historic role has been that of man's most versatile structural material. For this role it possesses unique strength, as well as other desirable properties. It isn't simply a question, though, of how strong a piece of wood is. To the FPL engineer, there are various kinds of strength, depending on how and where the load to be carried is imposed, how long it remains, how it is distributed, how quickly it is applied and removed and applied again, and so on. All these and others enter into engineering calculations of strength for a job. Likewise, they enter into considerations for research.

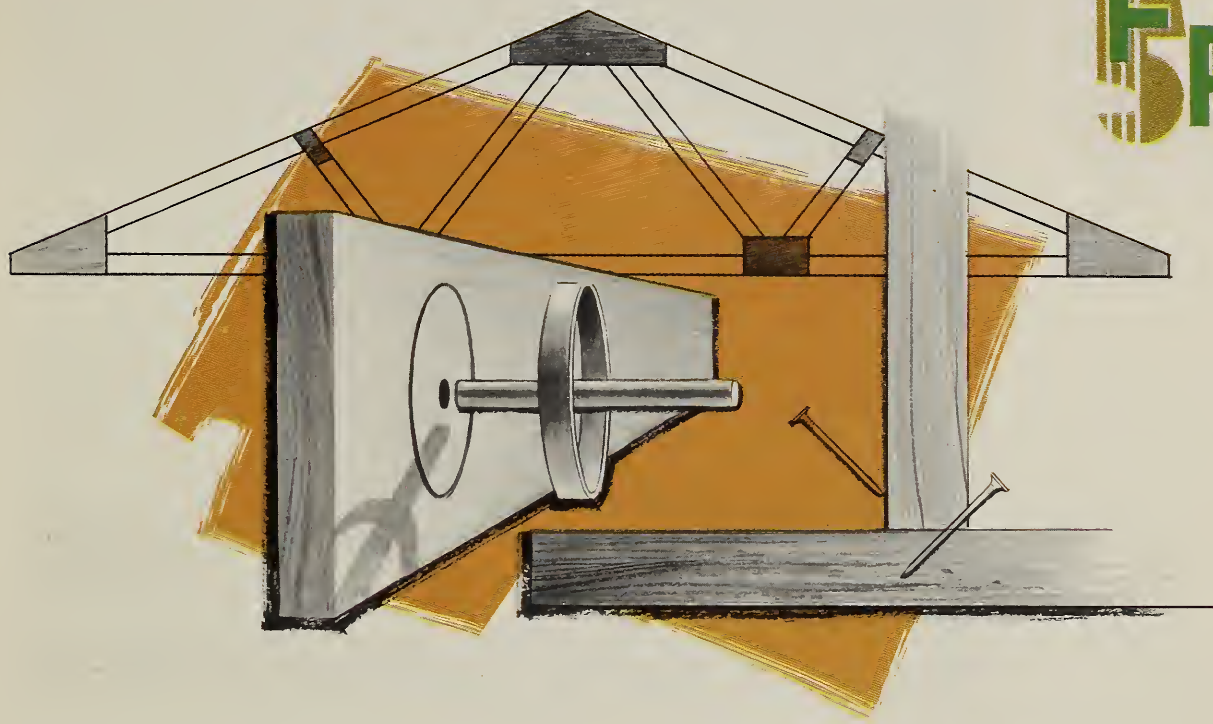
As a consequence, FPL engineering data on wood range all the way from simple values of pounds per square inch to complex design formulas compounded from test values, analysis, experience, and judgment. More than 175 native and foreign species have been meticulously screened.

This research starts with specimens as nearly representative as possible of the best quality in a species—clear, straight-grained, flawless specimens, selected from enough trees to give a representative sample of the forest population. They're tested in compression as a post, in bending as a floor beam, in shear, in impact, in vibrating machines. They're tested green and dry, hot and cold. When the results are charted, FPL research engineers have something to start with in setting up their design requirements for sizes and qualities of wood, kinds of fastenings, safety requirements, load and span limits, and all the other factors architects and engineers take into account.



"Our industry, with the contribution we may make to the economy, is just one of many examples of the benefits to the public through the work done by the United States Forest Products Laboratory."

Frank J. Hanrahan, Executive Vice President, American Institute of Timber Construction.



The Shape of Things

Finely blended together in wood are many properties and characteristics, largely the result of its unique fiber structure. The many species we have add greatly to the range of wood's uses, differing as they do in such basic properties as weight, hardness, and strength. Men long ago learned by experience that certain species are superior for certain uses. One of the first jobs FPL undertook was to find out why this is so and apply the resultant knowledge in seeking improvements and new uses.

Every detail of wood use comes under FPL scientific scrutiny. In large part, for example, the strength and durability of wood structures is limited by the joints and fastenings used to assemble the various parts. Nails, screws, bolts, and adhesives become legitimate objects of FPL research, as do the joints made with them and the structures so assembled. From the engineering standpoint any nailed structure, whether a box or a house, merits investigation as it involves wood use, as do bolted timber frameworks for large buildings and glued laminated arches and beams.

By establishing the most effective ways to join pieces of wood, FPL research helps to determine the shape of things made of this versatile material.

"One of the real problems with lumber has been its relative instability due to expansion and contraction under varying moisture conditions. Research to determine how water is held in wood and what can be done to remove it is progressing."

Frederick K. Weyerhaeuser, Chairman of the Board,
The Weyerhaeuser Company.

Seasoning to Suit

The life-sustaining liquid of trees we commonly call sap becomes, once the tree is felled, a liability for most uses we make of wood. Men long ago learned that wood serves better when the sap is out. Because it took months of dry, warm weather to cure wood in this way, the process came to be known as seasoning.

FPL research has brought about drastic alterations in commercial seasoning processes. Fundamental investigations of the nature of seasoning and its effects on wood paved the way. Better understanding of how moisture moves through wood, why some woods are relatively easy to dry and others tend to warp and check, and how heat affects the drying process—all such research has contributed basically important knowledge.

Applying this knowledge, FPL physicists originated fast kiln-drying procedures that do in days or weeks what used to take months or years—or couldn't be done at all. Today seasoning is a part of the lumber manufacturing process and readily modified to suit varied conditions of use.

"I can't emphasize strongly enough the key role . . . which has been played by the Forest Products Laboratory. It has been the fountainhead of the basic scientific data on which we and others have been able to build."

**W. E. Difford, Executive Vice President,
Douglas Fir Plywood Association.**

Rebirth of an Ancient Art

It is, of course, beyond dispute that plywood as we know it is strictly a triumph of twentieth-century technology. Yet it is equally true that, twenty centuries before Christ, men split wood into thin sheets which they bonded to chests as decorative face veneers. The evidence has been dug directly from ancient Egyptian tombs.

So, though the technology is new, the idea is ancient. And, of course, what was once reserved for Pharaohs is today commonplace in any American home: Veneered furniture, plywood cabinets, and even plywood itself overlaid with plastics for floors and countertops. And, often unseen, veneer and plywood are liberally used in floors, roofs, and walls, as well as fine paneling, millwork, and many other structural and decorative applications.

Plywood has distinct technological attributes. Its veneers are cut from logs with knives, thus avoiding sawdust losses. By bonding these veneers together so that the grain of adjoining ones is at right angles, swelling and shrinking are lessened. For outdoor uses, waterproof glues are available; indoors, plywood made with less expensive adhesives is suitable.

Research by FPL engineers has made it possible to create, with plywood, structures of radically fresh form and concept. And FPL processing investigations have shown how to use an ever-widening array of wood species, introduced better cutting, drying, and gluing techniques, improved rot and fire resistance . . . brought to modern fruition an idea 4,000 years old.

"Fortunately, we can stand here today and look back over the few short years that have passed since the Forest Products Laboratory . . . made the greatest single contribution to housing since the invention of the nail."

George E. Price, President, National Homes Corporation, representing Home Manufacturers Association.

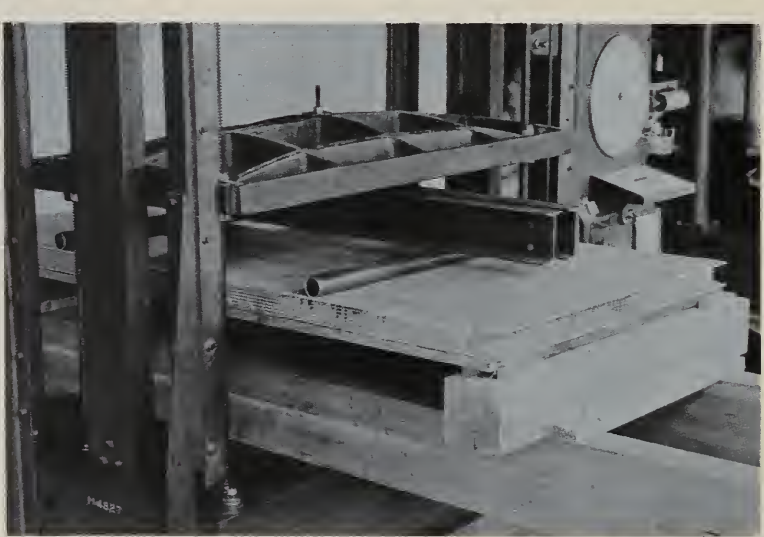
As the Skin is Stressed

The year was 1917. A new kind of war was propelling mankind into a new age. Our crude, flimsy-looking aircraft were getting their first acid test as fighting machines. On each side, engineers and scientists were hard at work on more airworthy designs.

Inevitably FPL scientists and engineers were drawn into the technological race. And from their broad program on such things as wing beams, ribs, and bulkheads, better glues and gluing methods, and plywood air surfaces came a new concept of structural design. They called it the "stressed-skin" principle.

That design principle was evolved from a basic requirement for aircraft—that every pound of material must work. Dead weight couldn't be tolerated. In plywood skins glued to spars, ribs, longerons, fuselage rings, and other parts of the airframe they found the solution. The plywood did its share of "work!" That is, it not only enclosed the framework but stiffened it against the stresses imposed by flight conditions. The key to this development was the continuous joint made possible by glue. Unlike nails and bolts, which impose severe stresses in concentrated areas when loaded or "working," glue joints transfer stresses evenly, so that the skin in effect becomes an extension of the frame.

The stressed-skin principle became widely adopted in aircraft design. Its greatest use, however, began a decade and a half later, when FPL engineers adapted it to mass production of house panels. Today's factory-built house industry has widely adopted it as a result of FPL's pioneering house research in the thirties.



"We continue to be . . . dependent upon other aspects of Madison's work—for example, the investigations in adhesives, pressure treating, and the combination of wood with other materials such as plastics and light metals."

W. E. Difford, Executive Vice President, Douglas Fir Plywood Association.

For a More Perfect Bond

The origin of wood glues is lost in antiquity. Adhesives reliably permanent under any kind of service did not exist, however, until hardly a quarter century ago. Then synthetic resins made from such common chemicals as carbolic acid and formaldehyde opened the way. Today they've largely replaced glues of hide, bone, hooves, and blood used for uncounted ages.

At FPL, the first synthetic resins emerging from Europe were quickly seized upon for adhesives research and development. By 1935, as a result, the first waterproof plywood was a reality, and glued laminated timbers of equal moisture resistance soon followed. When World War II broke out, enough research had been done to make possible better aircraft and troop-carrying gliders, PT boats, and non-magnetic minesweepers as FPL scientists and engineers worked with the Army Air Force, Navy, and private manufacturers.

Waterproof plywood is now commonplace in building construction, as are laminated arches, trusses, and heavy timbers. FPL resin-treated wood has proved so stable dimensionally that auto makers use it for die models of body parts. And synthetic resin binders have made possible a new kind of wood sheet called particle board. As manufacturers have brought out new resins, FPL has acted as a clearing house of information on them—in the process helping to "separate the sheep from the goats" by establishing properties and use conditions.

So broadly useful have these resins become that the combining of wood with metals, plastics, and other materials for all conditions of use is now attainable.

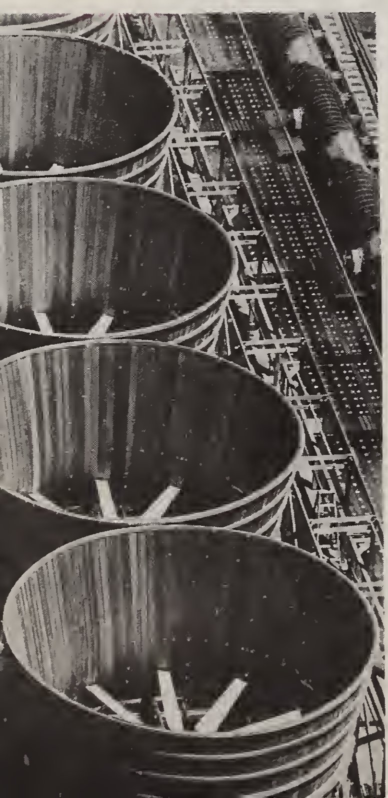
"RESOLVED, That the American Wood-Preservers' Association in meeting assembled gratefully acknowledge its indebtedness, (and) extend its best wishes for continued success . . ."

Text of plaque presented by J. M. Gurd, President, American Wood-Preservers' Association.

A Surprise for Mr. P.

Like all things that reproduce their kind, trees must be removed to make room for their offspring. Nature's uncompromising removal methods—mainly involving decay and insects—often conflict with the uses we make of wood. An important job for FPL research, consequently, is to find methods of preventing these scavengers from operating where they're not wanted.

Like all research, this calls for basic study. How, for example, does *Polyporus Versicolor* reduce wood to a crumbly mass? Having learned how fungi operate, the pathologist can devise protective measures. When wood must be used under damp conditions, as it often is, such protective measures are needed. The oldest, and the one now exclusively used, is literally to make wood poisonous to these rotters with preservative chemicals. United States railroads estimate that preservative treatment of ties, bridges, and wharves saves $130,000,000 a year. Basic FPL research has greatly aided the pressure treating industry.

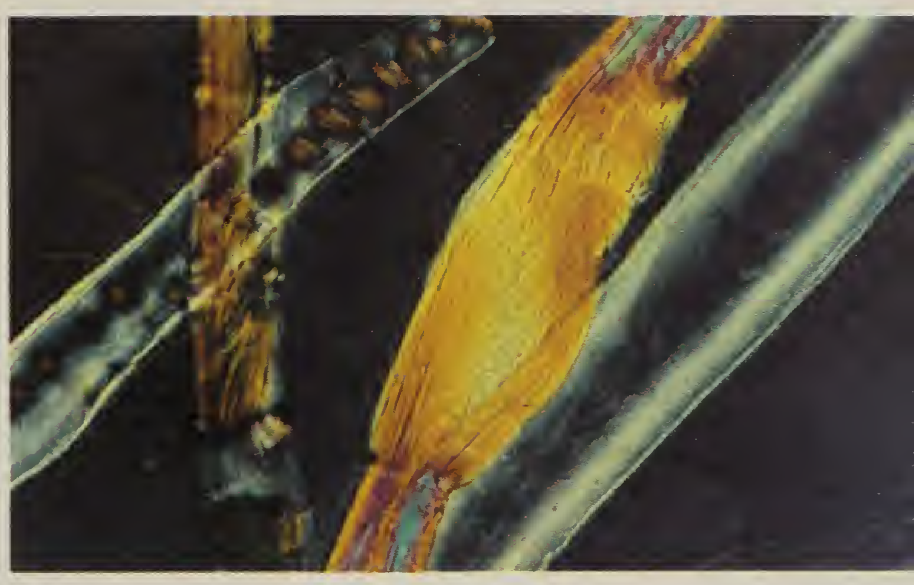


FPL research has uncovered effective treatments and chemicals. One process, called double diffusion, involves soaking green wood successively with water solutions of two chemicals that combine inside the wood to form an insoluble compound. Originally intended for fence posts, the process is used to spray huge water-cooling towers with preservatives that fend off fungi once thought harmless.

But poisonous chemicals may one day be unnecessary. FPL research has shown that wood becomes decay-resistant when treated to make the cellulose indigestible or to destroy its thiamine, a vitamin essential to fungus growth. The wood is left clean, odorfree, ready for any use—no doubt to the sometime dismay of Mr. *P. Versicolor* and his multitudinous relatives.

"Most of us in this room are fully aware of the important part that the paper industry plays in our daily life, providing many hundreds of services throughout all our activities in trade and business, in leisure and our lives at home."

Howard E. Whitaker, President, American Paper and Pulp Association.



Fibers for Abundance

Wood is so useful and valuable for so many things in its natural state that to grind it, cook it, and otherwise reconstitute it seems at first glance sheer folly. Yet some of the fastest growing branches of the forest products industries do just this—for paper, fiberboard, and the multitude of products made from them.

The reason, of course, is that wood is the richest and most concentrated source of natural fiber we have. And the profusion of fiber products made from it is woven inextricably into the fabric of our daily life. The abundance of such products available at low cost is no mere happenstance.

One of the main areas of research to which FPL was dedicated in 1910 was that of pulp and paper. Virtually the entire industry then depended upon northern spruce and fir. One clear target at which FPL's founders aimed its research was that dependency on so few species; they determined to broaden the species base on which the industry was built. Another object, of course, was to improve and expand the serviceability of wood fiber products.

One of the first major breakthroughs to which FPL contributed basic technology was the development of pulping and papermaking methods for the southern pines during the early twenties. These fast-growing species are today among our most important sources of wood fiber. At the same time, pulping, bleaching, refining, and other techniques were worked on for other species regarded then by industry as unsuitable for one reason or another. Among these was the whole category called hardwoods, or broadleaved trees, generally thought too short-fibered for use. But FPL's semichemical process of pulping changed that; and today these plentiful species are heavily harvested for practically any kind of paper. Coupled with research that has made western species suitable, this technological triumph has infinitely broadened our raw material base to include practically anything that grows beyond sapling size.

"One of the special arts of the papermaker is in choosing the fiber furnishes for the grades he must make or in choosing marketable grades for the pulps he must use. The . . . Forest Products Laboratory has contributed immensely to the science and understanding of this art."

Stanton W. Mead, President, Consolidated Water Power and Paper Co.

A Core and a Cover

A piece of paper seems a fragile thing. Yet the commerce of the world is largely transported in things made of it, from the common grocery bag to giant containers carrying burdens weighed in tons. And increasingly we use it to make structural parts of buildings, scuff and mar-resistant furniture and counter tops, defect-masking "overlays" for lumber and plywood, and a profusion of products. The technology making such profusion possible is largely traceable to FPL research.

That research has encompassed basic chemical and physical studies of fiber structure, inquiries into the effect of various pulping and paper-forming operations, engineering investigations of paper strength, and mathematical methods of calculating strength of container board and containers. From this broad-scale research has come a new technology enabling container engineers to design economical packaging of predetermined strength and durability.

From much the same sort of FPL research, structural engineers have gained useful methods of designing and fabricating structures with paper components, notably the sandwich panel with paper honeycomb cores. FPL-originated for housing, this type of panel has also found uses for walls and partitions, roofs and floors in office buildings and other structures.

FPL research on resin treatment of paper has led to such diversified products as dense, hard surface sheets for counters, furniture, and floorings, and masking overlays for plywood and lumber that weather remarkably well.

"Great efforts have been made to find uses for sawdust and bark of a higher economic value than for the production of power. We hope that some day a profitable chemical industry may evolve . . ."
Frederick K. Weyerhaeuser, Chairman of the Board,
The Weyerhaeuser Company.

From Charcoal to HMF

Ancient man discovered that controlled heating produced a chemically modified form of wood, and used it as a smoke-free fuel. We call it charcoal, and still convert a million tons of wood into it each year —for backyard barbecues, medicinals, metal refining, and so on.

Only during the past half century, however, has true chemical utilization of wood begun. It is today based on wood's chief constituent, cellulose, which yields synthetic fibers for clothing, tire cord, and other textiles, photographic film, transparent wraps, molded plastics, explosives, and rocket fuels, to name a few.

During the past two world wars, wood has been transformed chemically into other needed products, notably grain alcohol and wood-sugar feeds and foodstuffs.

In all these fields, FPL research continues to play important roles. In World War I, FPL chemists came up with activated charcoal for gas masks. Subsequent basic research has produced highly pure cellulose for better explosives and textiles; has gone far toward solving the riddle of what lignin, second most abundant chemical component of wood, consists of; and has developed better processes for converting wood to sugars, and in turn, to industrial chemicals such as acetic and butyric acid, glycerine, various alcohols, and two potentially important chemical intermediates, furfural and hydroxymethyl furfural (HMF).

The gains thus far achieved have brought us much closer to our goal of broad new chemical uses for wood—uses that require no particular quality of wood, hence can be based on wood now left unused or discarded in forest and mill.

And Four Equals Five

Suppose that somehow, like a motion picture run backwards, the world could be reversed on its axis and the years rolled back to 1910. The swift drop in living standards, the disappearance of physical comforts and conveniences, the shrinking of leisure time pursuits, and the lengthening of workdays and weeks would hit mankind like an implacable scourge. Far worse, however, would be the cumulative effect of our growing ignorance— the loss of the knowledge that has made all else possible.

The forest products industries can be drawn on to exemplify what would occur. Along with the return of much primeval forest would come the primitive methods of harvest and conversion that then dominated this industrial complex. Plywood as we know it would vanish, along with many kinds of paper, fiberboards, rayon, cellophane, adhesives, preservative chemicals, plastics, and the myriad things we make of them. Even our lumber would not be so well seasoned, machined, and graded as it can be now; nor would the products made of it be so uniformly dependable in quality.

Fortunately, the learning process, once established, is irreversible. This is especially true of an institution dedicated to the pursuit of scientific knowledge. In a laboratory such as FPL, the only interest in what has gone before is in how it can be used to shape the future.

The half-century of work highlighted in this booklet, therefore, has intrinsic value only as it helps us all to plan and prepare for the years to come. Necessarily, what has been written here can be only suggestive. Even in a topical sense, much has been omitted.

For example, the research that has built a foundation of solid engineering knowledge for our packaging profession has made enduring contributions to the transport of goods to every corner of our globe. FPL research in this field has shown how wood, paper, fiberboard can be more efficiently used in boxes, crates, cartons, bags, special wraps, cushioning, for the safe transport of sensitive instruments or massive machines. Research done under stress of World War II—which high officials credited with making four ships carry cargoes that had required five—has been continued during peace. Whether the carrier be a burro, camel, truck, ship, railroad, or airline, research has made the load easier, lighter, smaller, safer to carry. And, with a firm grip on today's problems, the investigators are looking skyward at what tomorrow's astronauts may need.

Other facets of FPL research that hold the seed for new advances include investigations aimed at gaining greater fire resistance, more durable exterior finishes, better quality in the raw material as well as the finished product. Implicit in all of this work is the continued exploration of basic physical and chemical properties. The fundamentals of wood pyrolysis are under examination for leads to new ways more effective than existing coatings and impregnants in preventing or stopping the burning process. The behavior of paint films when wetted or heated is studied for clues to better durability in rain and sun. The very microstructure of wood itself is probed with electron microscopes and x-rays to reveal hidden clues to superior quality in the growing tree.

The fruits of the first fifty years have been abundant; the research done amply rewarding. But the need for it grows more urgent as our society becomes more complex and our population multiplies upon a land unchanged in area. The acreage available for timber production is shrinking, and will continue to do so as land is taken for food, homes, industry, highways, power lines, airports. From the land that is left must come the wood, the fiber, the chemicals, the total forest wealth on which future generations can draw.

Though conditions have changed drastically, the goals for research that the founders of FPL conceived in 1910 are still valid. *Greater serviceability of wood . . . new and improved uses . . . augmented usefulness and quality . . .* these are objectives which, illumined by the experience of fifty years, gain even greater validity. It is fortunate indeed that timber, our most versatile of natural resources, has also the unique virtue of renewability. Our forests are truly automated factories constantly manufacturing anew, by processes that were old when man first appeared on this earth, the substance we call wood. We must understand these processes, aid and abet them and use their product more wisely, to insure for our heirs the goods and services, the jobs and industries that are indispensable underpinnings of our free way of life.

Toward these goals the Forest Products Laboratory was rededicated on the occasion of its fiftieth anniversary in June 1960. Its many-faceted program of research is geared to the demands of today and tomorrow—to the existing and future needs of our Nation as it is given us to see and anticipate them. Thus is continued, with all available facilities and manpower, a broad program guided toward better understanding and utilization of wood as a raw material for homes, schools, places for work and play; for myriad products of natural and synthetic fibers; and for the chemical wealth locked in its cellulose, lignin, and extractives.

What hidden capabilities, what structural secrets, what clues to growth and quality still elude our beams of polarized light, streams of electrons, and probing x-rays? How can we convert round logs more efficiently into the sizes and shapes we need; how join small pieces together edge to edge, end to end, or face to face? How armor things of wood more completely against service hazards, natural or man-made, to magnify their useful life? How dissect wood more perfectly for its fiber and chemical riches, thus eliminating the processing residues now dumped, burned, or otherwise disposed of at little or no return?

These are not questions that concern only the research man. They are hard, practical questions put to FPL by growers, harvesters, processors, users of wood in every part of the United States under widely fluctuating conditions of climate and service. They are questions that shape the course of research; and the answers found will in large part determine the future success of our forest-based industries and the satisfaction of the needs and wants of increasing numbers of men, women, and children.

From the research under way today will come tomorrow's technological breakthroughs and industrial advances. And as new knowledge and changing conditions create the need, new lines of research will be undertaken. The sum of it all will mean fresh solutions to what is ultimately the over-riding problem—the mathematically contradictory task of making four equal five, or six, or seven—of doing more with less—of achieving more intelligent use of our one great renewable resource, wood.

"*Better Wood Products through Research*"

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